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Atkinson - Cotton and Cotton Manufactures in the
U.S. - 1880.

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Edward Atkinson

Cotton & Cotton Manufactures in the U. S.
Boston, Mass., U.S.A., October, 1879.

Boston. 1884.

Here he writes on a subject on which he was an expert.
It is a pity he did not stick to what he understood. He
floundered badly on currency.

It is G. 2.

? Angelo Palgrave's copy. 1920.

COTTON

AND

COTTON MANUFACTURES

IN

THE UNITED STATES.

BY

EDWARD ATKINSON.

BOSTON, MASS., U.S.A., OCTOBER, 1879.

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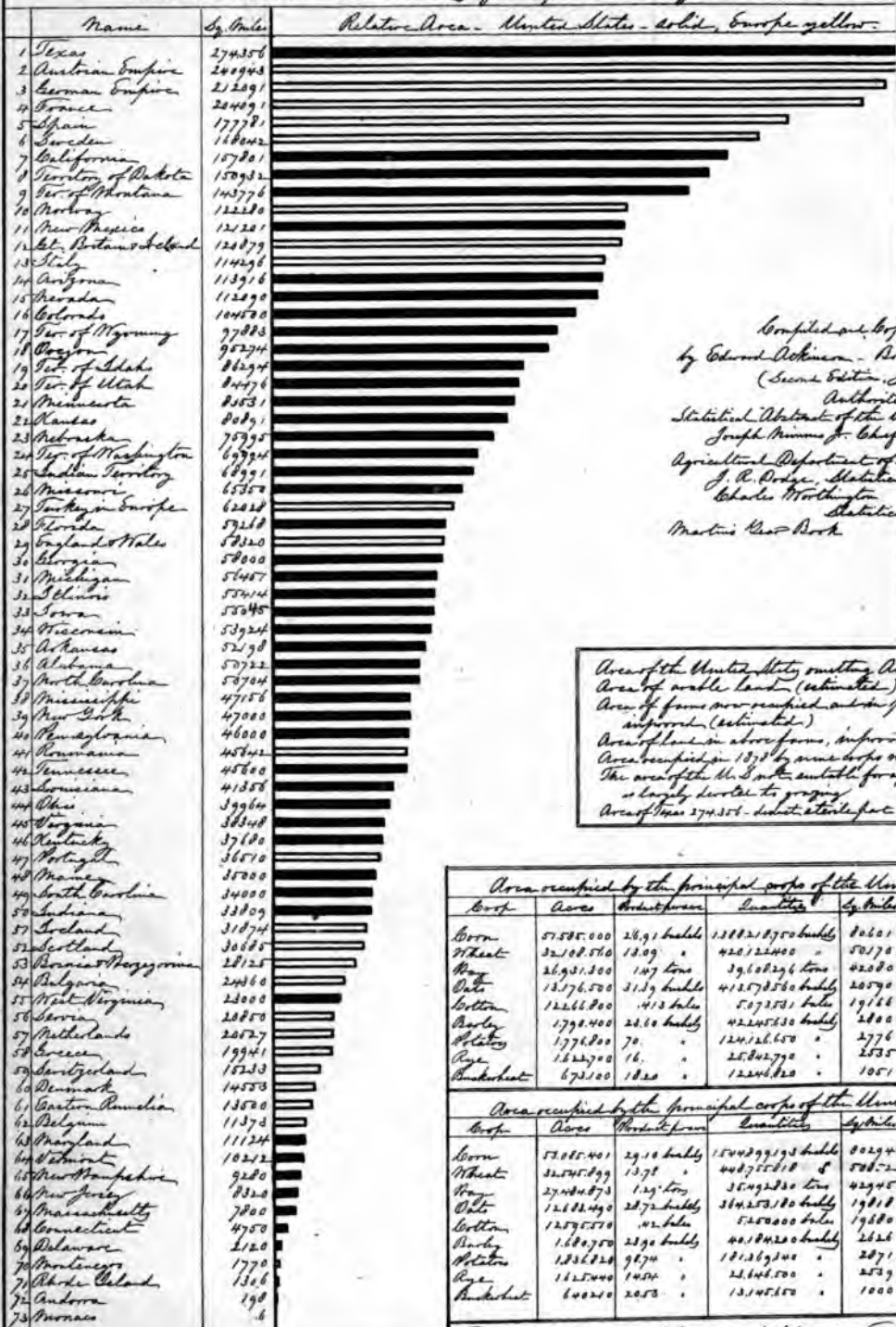
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Our National Domain.

Graphical presentation of the comparative areas of the States and Territories of the United States and the Countries of Europe. (Omitting Russia and Alaska.)



Compiled and
by Edward Robinson, Jr.
(Second Edition)
Author
Statistical Abstract of the U.
Joseph W. McKim, Jr. Chief
Agricultural Department of
J. R. Dodge, Statistician
Charles Worthington, Statistician
Martin East Rock

Area of the United States, omitting Alaska
Area of arable land (estimated)
Area of farms now occupied, and in process of improvement (estimated)
Area of land in arable farms, improved
Area occupied in 1872 by arable farms on the area of the U.S. with suitable farms as large by double the grazing
Area of Texas 274,356 - double the area of the U.S.

Area occupied by the principal crops of the U.S.				
Crop	Acres	Product per Acre	Quantity	Sq. Miles
Corn	57,585,000	24.91 bushels	1,424,218,750 bushels	80,601
Wheat	32,108,500	13.09 "	420,122,400 "	50,170
Oats	26,931,300	1.07 tons	28,908,276 tons	42,080
Barley	13,766,500	31.33 bushels	431,578,580 bushels	20,590
Cotton	12,266,800	4.13 bales	50,735,811 bales	19,166
Barley	1,798,400	24.60 bushels	44,245,840 bushels	2,800
Potatoes	1,776,800	70 "	124,376,800 "	2,776
Rye	1,622,700	16 "	26,042,700 "	2,535
Barley	672,100	18.20 "	12,246,820 "	1,051

The cotton crop of 1872 will be made up of 1871 - This
The cotton crop of 1872 will be made up of 1871 - This
The cotton crop of 1872 will be made up of 1871 - This

The cotton crop of Texas in 1872 was 951,000 bales, or nearly twice and a half the largest crop ever raised by it except 2,100,000 bales, reported on the scale of the chart by . The whole consumption of cotton was 1,500,000 bales, which could have been raised in Texas on less than 5000 sq. miles. The cotton crop of 1872 was 1,500,000 bales. On good land in Texas at 1 bale to the acre they would require less than 8000 square miles on all 71 to 12,000,000 bales of cotton of American weight, which could be grown in Texas on less than 19,000

THE
COMMERCIAL WEALTH OF THE UNITED STATES;
ITS
NATURAL PRODUCTS AND MANUFACTURES, AS INVITING
TRADE FROM FOREIGN NATIONS.

WE, as a nation, want access to the markets of the world, and not merely the chance to sell by seeking a market; but we need to make such an exhibit of our ability to rival other producers in offering the most desirable commodities, that foreign nations shall look to the United States as the best place for purchasing those natural productions and manufactures in which we abound.

The sharp apprehension of this need of a foreign market has been forced upon every thinking business man by the observation and experience of the past six years. The long depression in business has stimulated thought as to the causes of this depression, and the means of restoring business to its former activity, and keeping it in a stable and healthy condition as the country advances in population and power to produce. Different opinions prevail as to the efficient causes of our financial disasters, and many theories have been broached by practical business men and legislators as to the best means for restoring the country to sound business prosperity. But while these opinions have been so varied, and many of them antagonistic to each other, on one point all sensible men agree; and that is, that one great element in securing permanent success will be our ability to compete with other nations in the markets of the world with all our leading raw materials and manufactured products. To this all agree. They differ only in the means of reaching this result. The free-trader holds the doctrine of free trade, because he sees in it the direct method of reaching this result now; the protectionist holds his view, because he judges protection to be the best preparation for reaching the same re-

sult in the end. All look to the securing of a foreign market as a desirable result, because they see it to be an absolute necessity for permanent prosperity of such a nation as we are,—a nation abounding in all the raw materials that enter into the leading products demanded by the growing civilization of the world; a nation having the best food-producing territory on the globe; and a nation that, in consequence of its free government and wide-spread educational advantages, is noted for its inventions in labor-saving machinery in all the lines of useful production. A nation so situated and so constituted must produce vastly more in certain lines of industry than the home market can readily absorb. The producing power of wheat-fields, coal-fields, iron-beds, and waterfalls will be pushed to its greatest efficiency by such a people, so that a surplus will glut the market, depress prices, and paralyze business, unless there is a market among those foreign nations that are wanting the products in which we abound.

The case needs only to be stated, to make it apparent that foreign markets are a necessity for our progress in the very lines in which our activity has been for years moving; and that a nation so vast as ours in its resources not only must reach the markets of the world, but that it can do this successfully as a fair and generous competitor with the nations abounding in productions similar to our own. England has to-day one great advantage in that she is so well known. The nations have been accustomed to buy of her. This force of habit, this power of tradition, is strong in directing the currents of trade. The history of the past few years has shown, that, when our manufactures have become known, we have been able to compete with England even in her own markets. One of the great wants of our trade to-day is, that the nations of the world should know just what we can produce, and the prospect there is that we shall continue to produce these things in better quality and more cheaply than other nations. We need to let the merchants of the world know just what they can buy of us to the best advantage. The world-fairs have done much to aid us in this direction, but they have shown only the quality of the manufacture. They could give no adequate representation of the extent of our resources, and the combination of causes that will enable us to cheapen many staple products as no other nation can.

This is a subject that interests every producer, every business

man, artisan, and corporation. It is the small surplus in any product, that depresses the value of the whole below the cost of production, thus wiping out the profit on the whole, and destroying all reliability in business.

So mills go on half-time to diminish product. Half a product will yield a profit, while the whole product, by overstocking the market, would be sold at a loss.

When the markets of the world can be commanded, there can be no sudden piling up, because the area of distribution is too broad to be suddenly overstocked. Business becomes more steady with surer profits.

A man engaged in a business, the products of which are used only at home, is as much interested in the question of foreign markets as the one who trades directly abroad. The labor, or producing power, of a country, is wonderfully connected. It is like water in a great reservoir. Water drawn from any point affects the level of the whole. All labor, in a country, that finds a market in foreign lands, removes so much competition from those whose products are consumed at home. When foreign markets are shut off, all home markets have sharp competition from increase of laborers on the home-consumed products. Every yard of textile fabric sent out of the country gives a better market and better price for every yard sold in the country. Labor by the influence of the wide market is more certain of employment, and is better paid: so it matters little, considering the interests of the country as a whole, what specific article is sent abroad; it represents so much material removed from competition with products that are sold at home.

By the stimulus of foreign markets, also, labor is turned into the best channels,—into the channels where we can produce most at least cost.

It is good for a nation to have varied products; but the products and wants of the world are more varied than those of any one nation; and, when the world is the market-place, the call will be for those things in which we naturally excel,—things that we can produce at least cost. The producing of these is the most natural and most safe line for our industry. Thus the stability of business, and fair profits, are rendered more certain by securing foreign markets for any class of our products.

Influenced by these considerations, a wealthy association not identified with any special manufacturing or trade interest, but

impartially representing the whole country, have taken effective measures to make known to the world the advantages of American trade, the extent and richness of our markets.

They propose to carry out the work already begun, in part, by international exhibitions and in the scattered reports of our State and National Governments. It cannot be expected that these reports in all their details will be so understood by foreign nations as to sensibly influence trade. The materials which they present need to be digested; and the results, so far as they show an ability to meet the markets of the world, need to be so presented, and the works containing them to be so distributed, that every commercial centre of the world shall have easy and reliable means of knowing what we can do in supplying their wants.

The Association propose to publish a book on "The Wealth of the United States," setting forth especially our resources as a nation in raw materials and manufactured products. The book will probably contain about a thousand pages, with steel plates and woodcuts illustrating the extent and variety of our manufactures. Probably two years will be required for securing from the States and the United-States census reports the data required for making the work a standard authority for the next ten years.

It is intended to have all the great interests of every section of the country fully represented by writers best conversant with them. The whole work will be under the direction of myself as editor in chief, who will be held responsible for accuracy of statement, and that nothing shall appear in it, in the interest of any firm or corporation, in distinction from the great interests with which they are connected. No pecuniary aid is asked from any one in publishing the book; no direct profit is sought for in its publication. The Association look solely for their reward in the indirect benefits which they confidently expect to flow from their undertaking. The aim is, to have the work *national*, unbiassed by any individual or local interest.

The book will be printed in four editions, — English, French, German, and Spanish, — the latter especially for use in Mexico and Central and South America, — and perhaps in Russian and other languages. To secure the best possible distribution of the work, our Government, through the State Department at Washington, has agreed to instruct our consuls to collect infor-

mation in regard to commercial libraries and boards of trade in foreign countries, that the book may be placed in those where it will be accessible to the largest number of business men. A thousand volumes in each language will be presented to the libraries and institutions thus selected, through the agency of our consuls or the Smithsonian Institution. The cost of the work will not be less than fifty thousand dollars, which will be paid entirely by the Association in charge, so that no pecuniary obligation will be incurred upon which any special demand might be founded in favor of private interests. As the book will thus interest every man and business association, it is hoped that a certain kind of aid in the preparation of the work will be readily and cheerfully granted.

The request is hereby made of each board of trade in the commercial centres in our country, that they shall, in their *official capacity*, cause to be prepared for the use of the editor a statement of the business transacted by them, its nature and extent, — in fact, giving all the data and information which they wish to go forth to the world as influencing buyers in their market. In this way the editor will have the information that he needs for the work, and each section and interest will be duly represented.

When the editor is notified of the names of the persons or committees appointed by the official action of any association, or in the interest of any city or section of the country, blanks will be provided, so that the information may be definite and in as concise a form as is consistent with accuracy. The prompt action of all boards of trade and associations, by whom this article is read, is respectfully solicited.

P. A. CHADBOURNE.

WILLIAMS COLLEGE, WILLIAMSTOWN, MASS.,
Nov. 10, 1879.

COTTON AND COTTON-MANUFACTURE IN THE UNITED STATES.

BY EDWARD ATKINSON.

The cotton plant belongs to a family of which the **HIBISCUS** and **MALLOW** are well-known species, growing in the northern part of the United States and elsewhere. It is botanically known as *Gossypium*, under which name are classified several species and many varieties, both annual and perennial. It is indigenous to many parts of the world, both tropical and temperate; but the most useful sorts are those which grow in the southern part of the Temperate Zone. A tree cotton is found in the tropics, producing a fibre very silky and beautiful in appearance, but useless for want of the form and structure in the fibre which make it possible to spin the cotton of commerce.

A vine cotton is known in some of the West India Islands. In China and Japan may be found varieties producing a short, clean, and very white staple; in India many varieties commonly known as "Surats" (a name commonly applied to all East Indian cotton, but which really belongs to a single district) — also short in fibre, with the exception of one kind of long and fine staple produced in Dacca by a small class of people, with whom the cultivation is an hereditary employment, and from which the fine muslin known as the "woven wind" is manufactured. In Africa are to be found several varieties; but the only kind known to commerce is the valuable cotton of Egypt, next in quality to our "Sea Island" staple. Aside from this the cotton of Africa has a short and woolly staple. A small parcel imported by the writer from Lagos, during the late civil war, was worked into fabrics closely resembling a woollen flannel.

In Brazil a considerable quantity of useful cotton is now produced, and upon the Paraguay and Parana Rivers are vast tracts of land capable of producing the best varieties; but as yet these places are lacking in good governments, and the security to property which can alone assure adequate labor and good cultivation. The same may be said of Mexico. Cotton has also been raised in Asia Minor, Turkey, Italy, and in the islands of the Pacific. In fact, the area of land adapted in some degree to its growth is practically unlimited; but the

area that produces the most useful variety is practically limited to the Southern United States, the South American and Mexican soils being excluded from successful competition with them from want of stable governments.

The actual annual cotton crop of the world cannot be ascertained with precision, but an approximate estimate can be made. The commercial crop, or what may be called the portion which is worked by complex machinery contained in the factories of Europe and America, is accurately known. The most complete estimate is contained in the annual statement of Thomas Ellison of Liverpool, from whose last report the following data are taken:—

CONSUMPTION OF COTTON IN THE WORLD.

“In the following statement we give an approximate account of the quantity of cotton consumed in each country in Europe, and the various groups of countries in Asia, Africa, America, and Australia. The population figures represent thousands ($86,260 = 86,260,000$); the quantities of cotton and cotton goods represent millions of pounds ($142.5 = 142,500,000$ lbs.). There are three columns of quantities: First, the raw cotton spun in each country; second, the *weight* of goods and yarns imported into each country from Great Britain; and, third, the total of these two. The table also shows the *per capita* consumption in each country of raw cotton, of goods, &c., imported from England, and the aggregate of both. The population of Russia includes that of Asiatic Russia. The whole of the figures refer to the year 1877—the complete returns for 1878 not being yet published. In the column of “Goods, &c., imported from Great Britain,” there is a blank opposite Switzerland, because the shipments are sent *via* other countries. A large part of the Swiss production goes to Turkey and to various continental countries. Part of the production of Holland goes to Java, and part passes to Germany, Switzerland, &c. Belgium also forwards largely to the interior of the Continent. The exceptionally large consumption of cotton in the United States is owing to the smaller *per capita* consumption of wool and flax compared with Europe. Moreover, the figures include goods imported.

COUNTRIES.	POPULATION.	RAW COTTON CONSUMED.		GOODS IM-PORTED FROM GREAT BRITAIN.		TOTAL CONSUMPTION.	
		Pounds.	Per Head.	Pounds.	Per Head.	Pounds.	Per Head.
Russia	86,260	142.5	1.65	2.6	0.03	145.1	1.68
Sweden and Norway	6,291	24.8	3.94	8.0	1.27	32.8	5.21
Denmark	2,023	-	-	5.0	2.47	5.0	2.47
Germany	42,727	249.1	5.83	65.2	1.52	314.3	7.35
Austria	37,331	101.3	2.71	7.9	0.21	109.2	2.92
Holland	4,130	13.8	3.34	43.0	10.41	56.8	13.75
Belgium	5,336	43.2	8.09	17.4	3.26	60.6	11.35
Switzerland	2,778	42.5	15.30	-	-	42.5	15.30
France	36,906	230.0	6.23	19.9	0.54	249.9	6.77
Spain and Portugal	21,275	79.9	3.75	25.7	1.21	105.6	4.96
Italy and Malta	20,948	52.8	1.96	51.1	1.59	103.9	3.55
Greece	1,450	-	-	6.9	4.75	6.9	4.75
Turkey, Roumania, &c. . . .	15,353	-	-	37.0	2.40	37.0	2.40
	288,806	979.9	3.39	289.7	0.99	1,269.6	4.38
Russia	86,260	142.5	1.65	2.6	0.03	145.1	1.68
Rest of Continent	202,546	837.4	4.11	287.1	1.41	1,124.5	5.52
Great Britain	34,100	195.7	5.72	-	-	195.7	5.72
Total Europe	322,986	1,175.6	3.63	289.7	0.89	1,465.3	4.52
Turkey, Persia, &c.	24,540	-	-	38.0	1.54	38.0	1.54
India	250,000	295.0	1.18	350.0	1.32	625.0	2.50
China	435,000	1,000.0	2.29	100.0	0.23	1,100.0	2.52
Japan	33,620	65.0	1.98	20.0	0.59	85.0	2.52
Siam, Java, &c.	12,500	-	-	30.0	2.40	30.0	2.40
Total Asia	755,660	1,360.0	1.79	518.0	0.69	1,878.0	2.48
Egypt and North Africa . . .	17,000	-	-	34.0	2.00	34.0	2.00
West, South, and East Africa .	13,000	-	-	28.0	2.15	28.0	2.15
Interior of Africa	200,000	-	-	-	-	-	-
Total Africa	230,000	-	-	62.0	0.26	62.0	0.26
United States and Canada . .	48,850	628.0	12.85	22.0	0.45	650.0	13.30
Central and South America, and West India	43,250	-	-	135.0	3.12	135.0	3.12
Total America	92,100	628.0	6.82	157.0	1.70	785.0	8.52
Australia	2,650	-	-	15.0	5.66	15.0	5.66
The World	1,403,396	3,163.6	2.26	1,041.7	0.74	4,205.3	2.98

" Official reports show that the consumption of cotton goods in India is about two and one-half pounds per head per annum. We have assumed that a similar rate of consumption obtains in China and Japan. Russia imports some cotton from her Asiatic possessions. The quantity varies considerably. In 1861 it was only 150,000 poods of thirty-six pounds each; during the American war it rose to 750,000 poods; since then it has fallen off. Some cotton is grown and manufactured in the interior of Africa, but it is impossible to say how much. We cannot take the population as a basis, as estimates of *that* range from 150,000,000 to 400,000,000. We have adopted 200,000,000 in addition to the estimate of the number of inhabitants on what may be termed the margin of the Continent. Some native cotton is also consumed in Turkey and in the various countries of South America. The entire production of cotton in the world may be estimated as follows :—

	Pounds.
Imported into and consumed in Europe	2,217,000,000
Consumed in the United States	628,000,000
Native consumption in India, China, &c.	1,360,000,000
Total as above	4,205,000,000
Native consumption in Turkey	20,000,000
Native consumption in Africa, one pound per head	200,000,000
Native consumption in South America, &c.	40,000,000
Received by Persia from Bokhara, &c.	15,000,000
Total crop of the world	4,480,000,000
Equal to bales of 400 pounds	11,200,000
of which about one-half is grown in the United States. One-half of the whole is also spun in Europe."	

The writer would not fully accept Mr. Ellison's estimate, especially in reference to China, a country of which a large and densely populated portion is in a temperate zone where the winters are severe. Hence the estimate of only two and one-half pounds per head would be quite insufficient, as this is the average consumption of India, where a breech-cloth constitutes the entire dress of by far the largest part of the population. Gentlemen who have long dwelt in China—one holding high official position—concur in the writer's estimate of five pounds per head.

In considering this estimate, it must be remembered that cotton constitutes the chief material for clothing the inhabitants of China, India, and Central Asia, and also of Africa, and that as yet but a very small proportion of the inhabitants of these countries are clothed in fabrics made upon the machinery of either Europe or the United States. If we consider China separately, we can make an estimate of the possible future demand for fabrics made by machinery. The Chinese are a well-clothed people, and the substance of their clothing is mainly cotton; only the rich using silk or other fibres. The population of China is commonly estimated at from three to five hundred million; the latest Russian computation, which is probably based on the best information, reaching the latter number. Assuming that not less than twenty yards of what is known in England as a "China shirting," the fabric most largely exported from England to China, or sixteen yards of "China drill," such as we send in largest quantity, are required for the annual supply of a Chinaman, or about five pounds to each person, and using this unit as a divisor for the

annual export of cotton fabrics from England and the United States to China, combined, we find that if the goods were all used as the material for dress, it would not suffice for over thirty millions. But in fact English and American goods serve to clothe a much less number, as the largest portion of our heavy fabrics are used for the boat sails and awnings of the immense river population of the country. The rest of the people are clothed in hand-spun and hand-woven fabrics made from their own inferior, short-staple cotton.

Commerce has, as yet, reached but a fringe of China, and what may yet be its extension is an unsolved problem. In India, again, and in other parts of Asia, by far the largest portion of the population is clothed in hand-made fabrics; and the same is true of the unnumbered hordes of Africa.

It therefore seems probable that the unknown crop of cotton of the world is equal to the known, or commercial, crop. If the Chinese be estimated at 400,000,000 only, consuming five pounds each, or less than one-half the annual average consumption of the people of the United States, we find a requirement for 2,000,000,000 pounds of cloth, the product of 2,400,000,000 pounds of cotton, or 5,000,000 bales of 480 pounds each, — a quantity equal to the present annual crop of the United States.

What, then, is the chance of demand upon us that is implied by this statement? It may, perhaps, be said that the Chinese themselves will enter upon the construction of cotton factories, as has already happened in India; but in reply to this, let it be considered, —

First, That already the East Indian mills are importing American and Egyptian cottons, because of their superior quality, and because the additional quantity of cloth that can be produced in the factory where they are used compensates for the difference in price as compared to "Surats," and that the cotton of China is not even as well adapted to machinery as that of India, called "Surats."

Second, That the cost of manufacturing a yard of China drill in this country, or a yard of China shirting in England, aside from the material used, is less than a cent and a quarter, including the pay of every one employed, from the agent who controls the mill to the scrub who washes the floor.

Third, That in one of the largest mills in this country, now making drills for export, the average annual product of each

operative is 8,000 pounds, or enough to clothe 1,600 Chinese at five pounds each.

Fourth, That the proximity of the mills of New England to the cotton fields of the South gives them an average advantage of not less than one-half a cent, oftener three-fourths of a cent, a pound in the cost of cotton, as compared to their competitors in Lancashire, which advantage may enable their managers to pay at least twenty per cent higher wages, and yet produce a given kind of cloth at an equal cost.

Fifth, That the improvements and inventions which have been introduced into a given mill, which is a fair example of all, since 1860, have compassed the following results:—

1. A decrease in the proportion of the operatives to each thousand spindles (including with spindles the requisite proportion of preparation and of looms to make and finish the cloth ready for market), of from twenty-six and one-half to fifteen; or forty-three per cent.

2. A decrease in the cost of labor, per pound or yard of cloth, of twenty-one per cent.

3. An increase in women's earnings (women or girls constituting about three-fourths of the whole force), of thirty-three per cent.

At the same time, the improvements and inventions that have been applied in other branches of production have decreased the cost of all articles of comfort or necessity used by the operatives, so that each gold dollar of to-day will buy more of the necessities of life than the gold dollar of 1860.

If, then, the commercial crop of the world is now equal to a little more than 6,000,000 bales of American weight, of 480 pounds each, and the demand of nations that still use hand-made fabrics requires nearly or quite as much more, we have a total supply of 11,000,000 to 12,000,000 bales in all, or more than twice the quantity now raised in this country.

Upon what grounds can we assume that we shall year by year absorb an ever-increasing proportion of this staple production? and what are the conditions that have given us already such a paramount position in the matter?

The answer to this question needs only a consideration of the kinds of cotton we produce, the method of their production, the nature of our soil, and the adaptation of our climate to the growth of cotton.

Taking up these subjects in their order, we observe that there are but two general varieties of useful cotton.

First, the black or smooth seed cotton, in which class are included the Sea Island, Egyptian, and Brazilian staples. The Sea Island cotton, grown upon the islands of South Carolina, in Florida, and on the coast of Texas, is the finest variety known; it thrives in the sandy soil of the regions named, which sand is largely composed of minute shells or fragments of them. It needs salt in the soil and in the atmosphere, and the staple deteriorates if its cultivation is attempted inland. It is used for the manufacture of sewing-thread, and for the finest muslins and laces of Europe, but it is not an important factor in the cotton question.

Egyptian cotton is coarser and not so long, and with the South American cotton from Brazil is much used in England, France, and Switzerland, for the manufacture of the finer fabrics that are there woven. It has sometimes been assumed that Egypt might become a strong competitor with us in the production of cotton for the common uses that constitute the greater part of the manufacture; but it became evident, during our civil war, that the high price of cotton diverted too much of the labor of the people from the necessary work of raising food, and, although Egypt furnishes a considerable quantity of useful cotton, it is now very evident that no great increase can be expected from her soil.

We now come to the *green* or *woolly* seed cotton, which constitutes the greater part of the world's production, and which also constitutes the commercial crop of the United States. Of this variety must the twelve million bales needed in the world for its cheapest, most wholesome, and most useful material for clothing, mainly consist; and we now produce annually over five million bales, or nearly one-half of this whole quantity. The area required, at the present time, for this production, is about twelve million acres; but under the better methods, and with the use of fertilizers now prevailing, the average crop per acre is annually increasing.

Let it be considered, however, that this area is less than nineteen thousand square miles, and that the area of the ten cotton States is over six hundred and fifty thousand square miles, the State of Texas itself exceeding the area of the present Empire of Germany by about sixty thousand square miles.

Hence it appears that even if we were called upon to make the whole twelve million bales needed by the world, we could find good land equal to the entire need in Texas alone, or it could be divided between any two of the other cotton States, or all placed within the limits of the Indian Territory that is not yet open to settlement, and is not counted as a cotton country, without trenching in any degree upon land needed for other use.

The maintenance and increase of our crop is, therefore, a simple question of adequate labor, and not of land. What, then, is the labor to be thereto applied? In Texas, which now produces nearly one million bales, or twice and a half the largest crop ever raised within her limits in the days of slavery before the civil war, cotton is the product of white farmers; such is also the labor mainly applied in Northern Georgia, in many parts of Tennessee, and in North Carolina; but this is not our main dependence. It may now be affirmed that there is nowhere in the world a force of laborers that can be so easily controlled, so effectively worked, or so cheaply sustained, as the free colored laborers of the cotton States, when they are rightly and honestly treated. This allegation will doubtless be contested by many persons, but will not be questioned, but, on the contrary, will be fully sustained, by such Southern gentlemen as have learned to apply capital, intelligence, tact, and fair dealing, to the cultivation of cotton, sugar, and rice in the Southern States.

In respect to food, where else can there be found a force of laborers, the material for whose subsistence can be furnished for six cents or threepence a day,—giving them the food they like best, that on which they thrive most, and from which they can develop the most force? yet such has been the measure of the cost of the three and one-half pounds of bacon and the peck of meal, which, with one quart of molasses or syrup, constitutes the chosen and adequate weekly ration of an adult laborer in the cotton field; fish, game, and their own gardens furnishing them with their simple luxuries. It may be true that the Chinese and East Indians can be subsisted at less cost in money; but, if regard be given to the amount of force in the food, rice must yield to bacon and corn.

The dwelling, which to the freedman may be a palace compared to the quarters which he used to occupy, costs but little

money, and the climate calls for moderate expenditure for necessary clothing.

It is believed by those most competent to observe, that the colored population of the South is now rapidly increasing, after having been somewhat checked in its increase immediately after emancipation.

If we, then, possess a vast excess of good land, and a rapidly increasing force of effective laborers, it needs only to consider the climatic and geological conditions which have so rapidly restored our supremacy in the supply of cotton since the civil war.

The great Appalachian chain of mountains, extending from the north-east to the south-west, marks a line on which the moisture brought in from the great Gulf Stream of the Atlantic is condensed, — falling in showers over the Carolinas, Georgia, and Alabama, on whose uplands healthy homes for white cotton-farmers may be established almost without limit. To the west of this chain, the great valley of the Mississippi and its tributaries, bordered by bottom-lands of untold fertility, offer the boon of great crops to compensate for the less healthy condition of climate; yet on these rich river-bottoms, colored laborers who are free from danger of malaria may bring forth wealth in cotton, sugar, and rice.

In Texas the melting snows of the far-distant Rocky Mountains, flowing under the arid regions of the north-western part of the State, burst forth from the ground as rivers fully grown, lending moisture to the soil over vast areas even before the great springs appear that are the beginning of these rivers.

Throughout this vast area, the soil is filled with the shells of minute infusoria, that serve in part as the source of the inorganic material which is needed in very great quantity to produce the seed of the cotton plant.

Over all this area is found a climate that is not tropical; and in the largest part of it white men can live and work in comfort. The mean summer temperature of the upland cotton country is, in such places as Augusta, Ga., not as high as that of the lower portions of Philadelphia, in Pennsylvania, one of the largest cities of the North; while the extremes of heat in St. Louis, Mo., are greater than in New Orleans, La., yet nearly half the people of St. Louis are Germans.

To the Italians, the French, the Spanish, and the inhabitants

of South Germany, accustomed to the climate of warm countries, the Southern States offer homes and work that will assure a comfortable subsistence, with far more than the average opportunity to create wealth; and in almost every part the crop of cotton that may be raised may become a sure money crop, for which a market is always certain.

Since the removal of slavery, a great change has taken effect in the method of cultivation of cotton; the system of great plantations has nearly ended, and the farm system has taken its place; better tools and implements are being used, and such a field for invention and for new appliances is opening, as does not exist elsewhere in this country.

The effect of all these changes has been a rapid increase in the quantity of cotton produced since the civil war as compared to the years immediately preceding. The last ten cotton years, each ending Sept. 1, have yielded 6,459,803 bales more than the ten years preceding the war, as will appear from the table given below:—

CROPS OF		CROPS OF	
1870	3,154,946	1852	3,090,029
1871	4,352,317	1853	3,352,882
1872	2,974,351	1854	3,035,027
1873	3,930,508	1855	2,932,339
1874	4,170,388	1856	3,645,345
1875	3,832,991	1857	3,056,519
1876	4,669,288	1858	3,238,962
1877	4,485,423	1859	3,994,481
1878	4,811,000	1860	4,823,770
1879	5,073,531	1861	3,826,086
	41,454,743		34,995,440

This gain is largely, if not wholly, due to better cultivation, better tools, and to the vast increase in the use of fertilizers, giving larger products from smaller area.

It will be observed that the last five crops exceed the five crops immediately preceding the war, by nearly 4,000,000 bales; a gain of free labor of not less than \$200,000,000. The value of the ten last crops of cotton has been between \$2,500,000,000 and \$3,000,000,000 in gold.

If we consider what cotton is, and how it grows, we may get

a glimpse of the opportunity for improvement, invention, and discovery.

The fibre is the wing of the seed. In its immature state, it is a hollow cylinder filled with watery sap: when mature, the sap dries away, the cylinder collapses lengthwise, bursts the boll, and extends in length in a spiral form like a twisted ribbon, a little thicker at the edges than in the centre; it is attached to the seed at the base, and pointed at the end. It is this spiral form that causes the fibres to adhere to each other, and which makes it possible to spin it.

The production of fibre by the cotton plant, although most useful to mankind, is but a secondary function. The fibre is nearly pure carbon, hydrogen, and oxygen derived from the atmosphere; there is but little more than one pound in a hundred of inorganic material derived from the soil. The production of seed is the chief process which exhausts the soil; but when this seed is converted to such useful purposes that its inorganic material can be returned to the soil, the crop of cotton may be doubled, and yet the land grow richer instead of poorer. There are two to two and one-half pounds of seed to each pound of cotton; and four per cent of the weight of the seed is mineral element drawn from the soil, mostly phosphate of lime and potash.

The following analysis will give the relative quantities:—

ASH OF COTTON SEED.

Potash	36
Phosphoric acid	36.2
Magnesia	14.2
Lime	6.2
Sulphuric acid	4.1
Soda	1.1
Oxide of iron	.6
Chlorine	.5
Silica	Trace
Loss	1.1
	100

This analysis is one of many that have been made, and substantially agrees with others. Slight variations will occur, according to seasons and soils.

For every hundred pounds of cotton fibre, there are taken from the soil, in the seed, eight to ten pounds of precious min-

eral substances, all of which may be profitably saved. This process of saving is now beginning. In the old days of slavery this element of wealth was mostly wasted, and as yet it is too rudely treated to yield its full return.

Our present average crop of cotton fibre may be estimated at 5,000,000 bales of 480 pounds each, equal to 1,200,000 tons of 2,000 pounds each. At the rate of two and one-half pounds of dry seed to each pound of cotton, the seed crop is 3,000,000 tons, of which about 120,000 tons consist of mineral elements, as stated in the foregoing analysis.

The seed consists of about one-half kernel and one-half hull. They are easily separated, and the kernel is now largely used for oil, yielding about twelve and one-half per cent of its weight in oil of great value for many purposes. The oil cake is mostly exported to Europe, where it is used for feed, for which it is greatly valued, because the manure from cattle fed with it is richer in fertilizing property than that produced from any other known food.

The hulls have been mostly burned or wasted, but it is now evident that they must be all used. In New Orleans they were last year (1878) either thrown into the river by shiploads, or burned, and the ashes mostly wasted; but it was observed that if cattle had access to a pile of hulls they devoured them eagerly; and now all the hulls that are to be had are in demand, at ten to twelve dollars per ton, for feed. This was evidently a true perception on the part of the cattle, because a large portion of the mineral element is in the hull, and not in the kernel. It is therefore evident that the true use of the hulls is to grind them into meal with the oil cake, unless they prove to be too valuable for paper stock than to be used for feed. When bleached and pulped, they make a very strong material for paper.

That there is a great field for invention and discovery in the use of cotton seed in the arts, is very obvious; but it is very bad economy to remove that which constitutes the portion suitable for feed from the soil.

A very large portion of Northern and Western Georgia, South Carolina, Alabama, and Mississippi, has a light sandy soil of great fertility under proper treatment. In the neighborhood of Augusta, Ga., old fields, that have been so exhausted by unskilful cultivation in the old slave period as to produce only

one hundred and fifty pounds of cotton lint per acre, have been brought up to a product of over six hundred pounds of lint by the use of pine-leaves from the adjacent woods, and stable-manure.

There are within the limits of these States more square miles of light, sandy land, covered with pine-trees, than would be needed to produce the whole cotton crop of the world. This land is of easy cultivation, and peculiarly adapted to sheep-growing. It suffices only to girdle the pine-trees, and the timber will stand for fifty years in sound condition for use. When the tops die off, grasses come in that yield good sustenance to the sheep. But, under a proper method of treatment, these lands can be made more certain of yielding a bale of cotton to the acre than even the richest river-bottoms; because they are less liable to overflow and to insects. They may be more exposed to drought; but it must be remembered that cotton is a sun plant, sending its tap-root deep into the soil, and that dry years yield the largest crop of fibre.

These lands are free from malaria, not exposed to any degree of heat that renders them unfit for cultivation by white farmers, and are admirably adapted to the production of both wool and cotton: what more suitable method can be devised than to combine the two products?

It would seem to the observer that the right method would be to enclose the fields with the barbed wire fence that costs but a trifle, running the wire from tree to tree; and to alternate sheep and cotton, feeding the sheep on the ground meal and hulls of the cotton. Thus the cotton crop might be doubled, the wool clip added, the oil saved, and the land made richer year by year.

If a rotation of green crop is needed to interpose between the two, the use of the vetch, or cow-pea, may be considered for the third year.¹

At present it is alleged that sheep cannot be successfully kept in this region, owing to the pilfering of the negroes and the destruction of dogs; but it has been found, that if certain negro families have an interest in the pigs, chickens, and sheep

¹ The vetch, or cow-pea, is a plant of exceedingly rapid growth on sandy land, covering the ground with a heavy crop, sending its roots deep into the soil. It may be turned under, or allowed to decompose upon the surface; in either case serving its purpose as a fertilizer.

of the farm, stealing ceases. It has also been found, in California, that dogs prefer dead meats to live mutton, and will choose the pieces set up for them in the corners of the sheep-range; and that, if a little strychnine is added, it indisposes them for other meals.

Finally, it may be added, in respect to this branch of the subject, that although, under the slave system, there existed a class of planters of great intelligence who made the most effective use of the land that the system would permit, it was in its nature a wasteful system, and that at the present time the application of methods of saving has just begun.

There is a vast field for invention in the matter of new gins, — the saw-gin being in its nature unfit for its purpose: its only merit being the quantity of lint that it detaches from the seed. A beginning has been made in the invention of machinery for cleaning cotton more perfectly before it is ginned. New and better presses are also called for, for farm use.

In short, it may be said, in respect to the cotton of the United States, that half the world or more remains to be conquered; and yet half the work or more remains to be done in the utilization of seed, motes, and other waste, in the invention of the machines that ought to precede the work of the cotton factory, and in the application of new methods of cultivation.

It is to this work in our Southern land that the poor of other nations may betake themselves with every assurance of commanding comfort and welfare as time goes on.

The conclusion of the whole matter, in respect to the production of cotton in the United States, is this: Disregarding the bottom-lands, on which the heaviest crops of cotton are now made, there is a wholesome, salubrious upland country, of which the larger portion could now be bought, in an unimproved condition, at fifty cents to a dollar an acre, more than adequate to the production of the crop of the world; a region where white farmers can and do work in health and comfort, and where negro laborers can be hired.

In this section, the meat and corn most desired by the negro, and the necessary supply of clothing for an adult, can be bought for one dollar a week.

It is not intended to say that laborers are or ought to be satisfied with such a modicum of food and clothing, but simply to state that such a supply would, in connection with

the products of their gardens, be sufficient for health and strength.¹

Having thus endeavored to state the present condition and future prospect of the cotton production of the United States, let us now turn our attention to the second division of our subject.

¹ In order that the foregoing statement might not be considered that of a Northern theorist without practical knowledge of the subject, it has been submitted to several experienced cotton-growers in the South; and, after the correction of some minor errors by those to whom it was first submitted, it has been finally indorsed by a gentleman of great experience in the cultivation and purchase of cotton, both before the war and since, now residing in Middle Georgia.

He adds, in the following letter, valuable facts in regard to the effect of better cultivation on the habit of the cotton plant itself:—

"I have been glad to peruse your valuable document, and I am unable to suggest a line of criticism upon your statement.

"I do not consider sheep culture as profitable in the central portions of Georgia and South Carolina, as in the more northern and more southern localities.

"It is my opinion, the South has ten per cent less labor in the cultivation of cotton than prior to our civil strife. In slavery, women, boys, and girls ploughed and hoed: now the work of ploughing is by able men generally, the hoeing and picking by women and children; but quite a percentage of the latter do not now work in the field.

"We have an increase of white labor, especially in the more northern latitudes of our States (with a climate suited to the white man). Formerly it was supposed that in this section the seasons were too short and the climate too severe for cotton culture, and under the old method of culture such was true; but the use of fertilizers, more attention to the saving of barnyard manures, combined with the better methods of preparing and cultivating, have hastened the maturity of the plant and fruit so that the crop is fully one month earlier than in *ante-bellum* times.

"Old lands in cultivation for half a century can be restored by the application of top-soil from the forest of any upland plantation. Leaves decomposed, if properly applied, will give a beneficial result for about five years, by which time the forest will give a new supply of the same material. This, composted with cotton seed and acid phosphate, is the cheapest fertilizer; and barnyard manure adds materially to its value. This compost is a complete fertilizer for corn and cotton.

"The forty acres you inquire of have been in cultivation for half a century. Seven years ago they would not have produced over one bale to three acres; but, by the application of barnyard manure from eighteen animals, with ten bushels of cotton seed per acre, and one hundred and fifty pounds of pigs'-feet bone ground to a powder, annually applied, they have given a good result each year, until fifty-two bales, of four hundred and sixty-two pounds each, were gathered, and probably eight were lost by rot in the last cotton year.

"For the past few years the acid phosphate has been used; and at this time, but for the caterpillars, this field would give one and one-half bales per acre. The dried pigs' feet, ground into a powder, is the best and most durable of commercial fertilizers.

"If our planters would rotate their crops, oats followed by cow-pease,—the latter returned to the earth,—less of rust to cotton would be the result.

"Thorough, deep ploughing in the preparation, and shallow ploughing in the cultivation, have as much to do with the quick growth and good yield of cotton as the commercial fertilizers."

COTTON MANUFACTURES.

The cotton manufacturer of the United States may be now considered more firmly established than ever before. The method on which the business is conducted in the United States varies greatly from that of any other country; and this difference arises mainly from a difference not only in the habits and customs of the people, but also in their condition and intelligence.

The home market is the most important one, and may long continue to be so, although the export demand for our fabrics now takes seven to eight per cent of our annual product, and is likely to increase.

In contrast with the cotton manufacturer of Great Britain, our principal rival, we are therefore called upon to meet the demands of an intelligent class of customers living under substantially uniform conditions, and varying but little in their requirements. Hence we are not called upon for the great variety of fabrics that must be supplied by Great Britain. In consequence of this demand for a great variety of fabrics, the work of the cotton manufacture of England is much more divided than with us. With the exception of a few large establishments, working mainly to supply the home market, few goods are known in England by the name of the factory in which they are made, or are sold under the name of the manufacturer; but to a very large extent the yarn is spun in one establishment, woven in another, and finished in a third. The gray cloth is sold to the warehouseman, or to the merchant, to be stamped and packed by him, or to be dyed, bleached, or printed under his direction. If English goods had been sold under the name and stamp of the manufacturer, as cotton goods are in the United States, perhaps the substitution of clay for cotton might not have been carried to so great an extent. In the United States cotton goods are spun and woven in the same factory, and, whether sold in the gray or bleached, they are almost all stamped and marketed under the name of the factory in which they are made. Each factory, therefore, has its reputation to sustain, and, whether the fabric be coarse or fine, it is the effort of every one to make it good of its kind.

The same rule applies to printed calicoes. They are mar-

keted under the name of the works in which they have been printed; and the reputation and permanent existence of the works rest upon uniformity in quality, excellence in color and style, and constant progress in the art of design.

We may not claim to be more honest than our rivals, but it is a great error to suppose that it is permanently profitable to make an article that is not what it purports to be. A cotton fabric may be of a low grade, and may be intended to sell at a low price, but yet it is not profitable to substitute clay for cotton: the fabric, whatever it is, has its name and reputation, and must be true to them, or else the demand for it will cease sooner or later. Even goods that are made for linings, and that need to be starched and stiffened in order to be used, must have a uniform quality in the fabric itself to hold a permanent place in our market. Dyed goods that require to be woven on heavily sized warps, cannot be loaded with sizing, except by rule. If an attempt is made to introduce an article in which clay has been added to make it heavier, it is immediately detected; because the use of sewing-machines is almost universal, and the clay in the fabric heats the needle, and exposes the fraud.

It has therefore happened, that, although we have not until recently undertaken the manufacture of very fine fabrics, the average quality of the fabrics that we do make is better than that of any other nation, with the possible exception of France. It is for the wants of the million, that our cotton factories are mainly worked; and we have ceased to import staple goods, and shall never be likely to resume their import. On the other hand, we may for a long period continue to import the finer goods that depend mainly on fashion and style for their use, and that are purely articles of luxury. As has been stated, the substantial fabrics that constitute the main part of our cotton manufacture, and that are used by the masses of the people, are of the best of their kind, with the possible exception of those made in France. The French peasantry are a sagacious and truly economical race, and will not buy a poor fabric if they can get a good one; hence the cotton fabrics for their use are of a very substantial kind, and much more free from adulteration than those of any other country in Europe. The common cotton fabrics of England, Belgium, and Germany, could hardly be sold in the United States at any price.

The finest printed calicoes of France and England may be the best of their kind; but the printed calicoes for the use of the multitude, and which constitute the really important branch of this department of the manufacture, are of much better quality in the United States than in Europe, and are also of finer colors and more varied styles.

In fact, one of the chief obstacles that it has been necessary to overcome in the introduction of unbleached American cotton fabrics in the English market, and in other markets heretofore supplied by England, has been their apparently open texture, owing to the absence of heavy sizing. In the United States the sizing used upon the warp, and which is necessary in order to weave it, is made from corn or potato starch, free from any substance intended to make it heavier. In the gray cloth the sizing therefore constitutes only two and one-half to five per cent of the weight, and when the fabric is washed it shrinks more in measure than it loses in weight; hence a square yard washed and dried without stretching will be heavier than a square yard taken directly from the loom.

In England, on the other hand, even the pure sizing is made from wheat-flour, which is very glutinous; and the fabrics thus woven, even where no adulteration is intended, lose ten to twelve per cent of their weight on the first washing. These pure goods are, however, made chiefly for the home consumption of the richer classes of England. The greater part of the English cotton fabrics exported or used by the working classes are loaded with clay and other substances, from ten to forty per cent. The art of sizing has been highly perfected in England, and has been made the subject of very numerous patents; and, as the use of clay and flour to the extent of one hundred pounds to each one hundred pounds of cotton warp yarn involves great danger of mildew, many ingenious chemical applications have also been patented to serve as antiseptics; such as chloride of zinc, chloride of calcium, common salt, white vitriol, &c. These various antiseptics are compounded with flour, gypsum, soap-stone, China clay, and other heavy substances, in various ways. The English text-books upon the art of sizing are instructive and suggestive, especially in respect to the rules for the purchase of the most glutinous kinds of flour, and for the detection of *adulteration* in the flour; it being obvious that unless the flour is pure, and well adapted to the

purpose, it would be necessary to use cotton instead of clay to make up the weight of the fabric.

It will of course take a good deal of time to accustom buyers to the more open texture of cotton fabrics in which no clay is used; but, as time passes, American fabrics are being steadily substituted for those previously used by foreign nations, especially in China.

Since the year 1860 the cotton manufacture of the United States has been exposed to greater vicissitudes than any other important branch of national industry; and the wonder is not that there should have been some disasters, but that it should have survived at all in the hands of its original owners. In 1860 the whole number of spindles in the United States was 5,235,000. From 1857 to 1860 the cost of constructing a spinning and weaving factory on medium fabrics woven of No. 25 yarn was from \$16 to \$20 per spindle. (The number designates the number of skeins, of 840 yards of yarn each, in one pound.) The value of a bale of cotton of 480 pounds was \$40 to \$50. Then came the combined effects of war, paper money, and scarcity of cotton. At one period, more than two-thirds of the cotton machinery of the United States was stopped; the value of a bale of cotton rose to over \$900, and the price of some kinds of goods was seven to eight times the present price. A little later new mills were constructed, which cost \$30 to \$40 per spindle.

At the present time, September, 1879, there are not less than 10,500,000 spindles in the country, and each spindle is more effective than that of 1860; the value of the bale of cotton is again \$40 to \$50; the standard printing-cloth, which reached thirty-three cents a yard during the war, is worth four cents; the No. 25 mill for spinning and weaving can be built for \$12 to \$15 per spindle; our export of cotton fabrics is more in value and much more in quantity than in 1860, and the only check to its steady and profitable increase is the renewal of the home demand. Such have been the changes and fluctuations; yet, despite them all, not one spindle in ten has passed from the ownership of the person, firm, or corporation in whose possession it was in 1860, except in the regular process of bequest or voluntary sale.

During the period of inflation or of great vicissitude, the attention of the managers of the property was of necessity

devoted to other matters than the improvements and minute savings in which the profit of the business now consists; but during the last few years very great improvements have been made, and the lesson of economy and saving has been learned. The best example that can be cited may be found in the record of one great factory working upon coarse and substantial fabrics, and consuming more than 20,000 bales of cotton a year. Sixty per cent of its product is sold for export to various parts of the world.

The proportion of operatives to each thousand spindles has been decreased forty-three per cent, or from twenty-six and one-half to fifteen.

The wages of women, who constitute more than two-thirds of the operatives, have been increased thirty-three per cent.

The cost of making the cloth, aside from the material used, has been decreased twenty-one per cent.

In 1860 the average product of one operative, working one year, was 5,317 pounds; in 1878, 7,928 pounds of drill, such as is exported to China. Assuming five pounds, or about sixteen yards, as the annual requirement of a Chinaman for dress, in 1860 one Lowell operative, working one year, clothed 1,063 Chinese; in 1878 one could supply 1,586. It will be obvious that no hand spinning and weaving can compete with this product of machinery; yet the machine-made fabrics of Europe and America combined have as yet reached only six or eight in a hundred of the Chinese. How soon the rest will be clothed in cotton fabrics made by machinery from American cotton, therefore, depends but little on whether the wages of the Lowell factory-girl be four or six dollars per week, but rather on what exchangeable products the Chinese can produce better or cheaper than we can. The more tea, silk, sugar, and other commodities we buy from them, the more cotton fabrics, and other products in which we excel, will they buy from us.

It has been held that the cotton of America must be more and more used, both in America and elsewhere, and that, as time goes on, almost every other kind, with the exception of the cotton of Egypt, must give place to it.

To what extent may the same pre-eminence be secured for the cotton fabrics of the United States in the markets of the world, that we have secured in respect to the cotton fibre?

In the consideration of this branch of the subject, our atten-

tion must be given to the present condition of competition between the mills of the Middle and Eastern States with the mills of Great Britain.

In respect to the Eastern States, the cotton factories of Lowell, Mass., Manchester, N.H., Biddeford and Lewiston, Me., may be considered in their relation to the factories of Manchester, Stockport, Preston, and Bolton, in England. For the purposes of this comparison it may be assumed that there can be no permanent advantage of one set of mills over the other in respect to the quality and perfection of the machinery. At any given time, some advantage may be claimed and admitted on either side, in some special department of the mill; but every invention or improvement will sooner or later be adopted on both sides.

The supremacy in the art of converting cotton into cloth must ultimately fall to that country or section that possesses the advantage in respect to the conditions offered to the operatives, and in proximity to the source of the raw material.

The best conditions of life for the operatives, and the best prospect of improving their condition and that of their children, are of the gravest importance. The factors in this problem are education, shelter, subsistence, and opportunity for other kinds of work. In respect to education, the common-school system of the United States assures a thorough training, free of cost; and in the principal towns and cities free education is carried to the point of preparing the pupil to enter a university.

In respect to the subsistence, the factories of New England are three thousand miles nearer the wheat-fields and grazing-grounds of the West than those of Lancashire; and, so long as Europe buys food of America, our own mills must have the advantage of proximity to the Western prairies. In respect to the rents of dwelling-houses, there cannot long be any difference if there is any at present; because the materials for construction are most abundant in America. Opportunity for other work than that of the factory must continue for many generations, and until this continent is peopled.

In comparing our power to compete with England, we may claim advantages of one kind, and with the nations of continental Europe advantages of another, in some respects of a different order. In competition with England it is often

claimed that our chief advantage lies in a certain alleged versatility and power of adapting means to ends, and in great quickness of perception on the part of working-people in respect to the advantages to be gained by the adoption of new processes or inventions. If we have this advantage, there must be special causes for it in the influences that are brought to bear upon the operatives and artisans who do the work; for a very large proportion of them are foreign-born, or are the children of foreign immigrants. Why should they work with any more zeal or judgment here than in the countries whence they have come? Why are Irish and French Canadian factory-hands to be relied on for more steady work, larger product, better discipline, and more cleanly and wholesome conditions of life, than the operatives of England, Belgium, and Germany? To the writer it appears evident that these advantages, so far as they exist, are due mainly to the following circumstances:—

First, Our system of common and purely secular schools, attended by the children of rich and poor alike.

Second, Manhood suffrage.

Third, The easy acquisition of land.

Fourth, The habit of saving small sums, induced by the establishment of savings banks throughout the manufacturing States.

Fifth, The absence of a standing army, and the application of the revenue derived from taxes on the whole to useful purposes.

In respect to the first of these influences, the public-school system, the foreign observer generally takes notice only of the quality of the instruction given, and, though he may find something to praise, he finds also much to blame; he finds in many cases the instruction bad, and the subjects often ill-chosen, and he wonders at the misdirection of a force that might be so much more wisely applied. What he fails to notice is that the school itself, entirely apart from its instruction, is the great educator of the children who attend it. The school is, first of all, no respecter of persons: the stupid son of a rich man, led in every class by the son of a mechanic, cannot in after-life look down on him as an inferior, whatever the conventional position of the two may be; or, if the rich man's son have brains as well as fortune, the poor man's son can never attribute to fortune only the lead that he may take in after-life. The school is thoroughly

democratic, and each pupil learns in it that it depends on himself alone what place he may take in after-life; and that, although society may be divided into planes, there is no system of caste, and no barrier in the way of social success, except the want of character and ability to attain it. The associations of the common school utterly prevent any thing like servility in the relation of classes in after-life; and although it is sometimes made a little too manifest that "one man is as good as another, and a little better," on the part of those who are more eager than discreet in their effort to rise, yet, on the whole, the relation of the various classes, which must in the nature of things always and everywhere exist, is that of mutual respect, and any thing like the Old World distinctions of caste and rank would seem about as absurd to one as to the other. The common school is the solvent of race, creed, nationality, and condition.

In another way the discipline of the school affects the processes of manufacture. In the schools, cleanliness, order, and regular habits are enforced, with deference to the teachers, and respect for authority; and in these later years coupled with the teaching of music and drawing in all the principal towns and cities. When children thus trained are removed to the mill or the workshop, habits of order and cleanliness, with some æsthetic taste, are already established. Nothing strikes an American manufacturer with so much surprise as the extreme untidiness of the large textile mills of England, and the dreariness of the factory-towns. In this respect, however, it must be confessed that the managers of the New England mills are greatly aided by the absence of smoke, the coal commonly used being anthracite. Much surprise is often expressed by our foreign visitors at the amount of decoration permitted in the fitting of stationary and locomotive engines, and in much of our machinery; but, bad as the taste displayed may sometimes be, it is nevertheless a fact that such engines or machines are better cared for and kept in better repair than where no individuality, so to speak, is permitted. On one of our great railways the attempt was not long since made to despatch the locomotives as they happened to arrive at the central station, sometimes with one and sometimes with another engine-driver; but the immediate and great increase in the repair-account caused the corporation to return very soon to the customary plan of giving each driver his own locomotive with which he may be identified.

The instruction of the school also gives every pupil a superficial knowledge, if no more, of the geography and resources of the country, which the universal habit of reading newspapers keeps up. Hence comes the almost entire absence of any fixed character in the labor of the country: every boy believes that he can achieve success somewhere else, if not at home. No congestion of labor can last long. The war and the succeeding railway mania combined concentrated population at certain points to a greater extent than ever happened before, and it has taken five years to overcome the difficulty; but within these five years a million new inhabitants in Texas, half a million in Kansas, and probably a million and a half added to the population of Nebraska, Colorado, Minnesota, and the far North-West, indicate that the evil has already found a remedy.

It is already apparent that a very slight increase in the demand for skilled workmen in certain branches of employment would not easily be met in the Eastern States, except by drawing upon England and Germany. During the years of depression, the cessation of railway-building, and the use of the excess of railway plant existing in 1873, has caused the dispersion of a large portion of the trained mechanics and artisans who then did the work of supplying this demand; but these are not the men who have crowded the Eastern cities, and caused the apparent excess of laborers out of work: such men have gone back to the land, or in the new States and Territories have found other ways in which to apply their skill and energy, and they will not return. It may be that the greatest danger to the manufacturers of England will not be in our competition in the sale of goods in neutral markets, but in our competition for the skilled workmen and artisans who make these goods, when we again offer them equal or higher wages, and better conditions of life, in the work that will very soon need to be done to supply the increasing demand in our own country.

The patent system may here be cited also as a factor in our industrial system. It has been carried to an almost absurd extreme; so that it is not safe for any one to adopt a new method, machine, or part of a machine, and attempt to use it quietly and without taking out a patent, lest some sharp person, seeing it in use and not published, shall himself secure a patent, and come back to the real inventor with a claim for royalty.

Manhood suffrage — subject as it is to great abuses, and dif-

ficult as it has made the problem of the self-government of great cities where voters do not meet each other, as in the town-meeting, face to face, but where the powers of government are of necessity delegated to men of whom the voters can have little personal knowledge—yet works distinctly in the direction of the safety, stability, and order of the community. Outside of two or three of the very largest cities, where there are concentrated great masses of illiterate *foreign-born* citizens, it would be difficult to find a case of serious abuse of the power of taxation, except in the South, since the war, where the evil is now mainly abated.

The easy acquisition of land throughout the country, under simple forms of conveyance, registered in every county, gives a motive to economy, and induces habits of saving that are of supreme importance in their effect on society. In the town in which the writer lives, — and in which he himself can remember the coming of the first Irishman who became a land-owner, — out of about one thousand owners of real estate, over two hundred are of Irish birth or extraction. The richest one among them came from Ireland in 1846, a steerage passenger. He now pays taxes on property of the value of fifty thousand dollars, almost all in real estate; his son is superintendent of the repairs of highways, and one of the most efficient members of the school committee.

During the last thirty years, the factory population of New England has passed through three phases. First came the sons and daughters of the New England farmer; but, as the sewing-machine and other inventions opened new demands for women's work, women of American birth passed out to easier or better paid employments, while the men took up other branches requiring more individual skill. Their places were taken mainly by Irish, with a few Germans and English. But as the Irish saved their earnings, and as the New England yeomen emigrated to the richer lands of the great West, they passed out of the mills to buy up the deserted farms of the poorer Northeastern States, where, by their persistent industry and manual labor, they achieve success, and gain a position which satisfies them, but with which the native New Englander is no longer contented. Their places in the mills are now being more and more taken by the French Canadians, who, in their new conditions and surroundings, show little of the stolid and unprogress-

ive character which has kept them so long contented on their little strips of land on the St. Lawrence River. In the very air they breathe they seem to imbibe a new and restless energy, while the intelligence shown by their children in the schools augurs well for their future progress. On the whole, the simplicity of our system of land-tenure, and the ease with which small parcels may be obtained, must be rated among the most important factors in considering our possible advantage over other countries.

Next in our list comes the savings bank. In 1875, out of the sixteen hundred and fifty-two thousand inhabitants of Massachusetts, seven hundred and twenty thousand were depositors in savings banks to the amount of two hundred and thirty-eight million dollars (£49,000,000). During the late years of depression the deposit has decreased somewhat in amount, but the decrease has been chiefly owing to the withdrawal of money for other investment, especially in United States bonds. There have been some failures of banks, and some losses, as might well have been expected; but they have been less than in any other branch of business; and the savings-bank system stands firmly based on well-earned confidence, and offers an easy means of saving the smallest sums to every man, woman, and child in the State.

To these causes of quick adaptation to any conditions that may arise, or to any necessity for the application of new methods or devices, may be added the custom, which has almost the force of law, of an equal distribution of estates among the children of the testator. *Tools to him who can use them*, is the unwritten law; and neither land nor capital can remain long in the possession of him who cannot direct or use them wisely. Liberty to distribute is esteemed as important a factor in our body politic as liberty to accumulate, even though the liberty may sometimes lead to the apparent waste of great fortunes.

Finally, it must be held that our freedom from the blood-tax of a standing army, and the fact that the proceeds of taxation are, on the whole, usefully and productively expended, are among our greatest advantages; and this is asserted with confidence, notwithstanding the misgovernment of some great cities, and of several of the Southern States. What are these failures but proofs of the general confidence of the people in local self-government? Great frauds and great abuses can only happen

where integrity is the common rule: where each man distrusts his neighbor, or each town, city, or State distrusts the next, the opportunity for fraud or breach of trust cannot occur. The use of inconvertible paper money during late years has not been without its necessary malign result upon the character of the people, and the newspapers are filled with the fraud and corruption that have come to light; but no newspaper has ever yet recorded one fact that offsets many frauds. In the great Boston fire, one of the Boston banks lost, not only every book of account, but every security and note that was in its vaults, amounting to over twelve hundred and fifty thousand dollars. On the morning after the fire, its officers had no evidence or record by which any of the persons or corporators who owed it money could be held to their contracts: yet, within a very short time, duplicate notes were voluntarily brought in by its debtors, many of whom knew not whether they could ever pay them, because the fire had destroyed their own property; and the ultimate loss of that bank, from the burning of its books and securities, was less than ten thousand dollars.

Our army is but a border-police; and, although its officers are held in honor and esteem, military life is not a career that very many seek; and, as time goes on, it will become less and less an occupation to be desired. Thus we are spared not only the tax for its support, but the worse tax of the withdrawal of its members from useful and productive pursuits. It is in this respect that we claim our greatest advantage over the nations of continental Europe. What have we to fear from the competition of Germany, if we really undertake to beat her in the neutral markets which we can reach as readily as she can? For a little while the better instruction of her merchants, in her technical and commercial schools, may give her advantage; but that can be overcome in a single generation, or as soon as the need is felt with us, as it is now beginning to be felt. After we shall have supplied our present want of technical education, the mere difference between the presence of her great army on her soil and its necessary support, and the absence of such a tax on us, will constitute the difference on which modern commerce turns, when the traffic of the world turns on half a cent a yard, a cent a bushel, or a halfpenny a pound, on the great staples. No nation can long succeed in holding the traffic, that is handicapped with a standing army. The protection of Ger-

many from our competition in neutral markets may be offset in our yet more dangerous competition for men. The German already knows Texas; and, in the one block of sixty thousand square miles of land by which the State of Texas exceeds the area of the German Empire, we offer room and healthy conditions of life for millions of immigrants. And on that single square of land, if they come in sufficient numbers, they can raise as much cotton as is now raised in the whole South,—that is to say, five million bales; and as much wheat as is now raised in the whole North, that is to say, four hundred million bushels,—and yet subsist themselves besides on what is left of this little patch that will not be needed for these two crops.

It will be obvious that even the least imaginative cannot but be moved by the influences that have been designated, and that versatility and readiness to adopt every labor-saving device will not only be promoted, but absolutely forced into action, when such vast areas are to be occupied, and when even the dullest boy is educated in the belief that he also is to be one of those who are to build up this nation to the full measure of its high calling. We may not dare to boast, in view of all we have passed through; but we know that slavery has been destroyed, and that the nation lives stronger, truer, and more vigorous, than ever before. We know that it has been reserved for a democratic republic to be the first among nations that, having issued government notes, and made them legal tender, has resumed payment in coin without repudiation or reduction of the promise. We know that we have paid a third of our great national debt already, and that the rest is now mainly held by our own citizens. We know that within the lives of men of middle age now living the nation will number one hundred millions, and that, in whatever else we may be found wanting, we cannot long be kept back in our career of material prosperity, which shall be shared with absolute certainty by every one who brings to the work health, integrity, and energy.

If there is any force in this reasoning, our competition with other manufacturing countries, in supplying neutral markets with manufactured goods, will not be compassed by low rates of wages paid to our factory-operatives, or to the working-people engaged in our metal-works and other occupations, but first by obtaining and keeping such an advanced position in the application and use of improved tools and machinery as shall

make high wages consistent with a low cost of production; secondly, by our ability to obtain the raw materials at as low or lower cost. Every employer knows that among employées who are paid by the piece, it is the operative that gains the largest earnings whose production costs the least, because under the control of such operatives the machinery is most effectively guided during working-hours. As it is with single operatives, so it is with large masses,—if well instructed, and working under the incentives to industry and frugality that have been named, their large product will earn for them ample wages, and yet result in low cost of labor to the employer. Such workmen never have any “blue Monday.” The workman who in this country habitually becomes intoxicated is soon discharged; and his place is filled by one who respects himself, and values his place too much to risk his position in dissipation.

Competition with England in supplying the markets of Asia, Africa, and South America with cotton goods, is now perhaps the best criterion by which to gauge our ability to compete in other branches of manufacture. It has been often assumed in England, that the increasing shipments of cotton goods from this country have been forced by necessity, and merely consisted of lots sold below cost as a means of obtaining ready money; but there is no ground whatever for this general assumption, even though some small shipments may have been made at first with this view. Our export of cotton fabrics amounts as yet to but seven or eight per cent of our production, and is but a trifle compared to that of Great Britain; but it is not made at a loss, and it constitutes a most important element in the returning prosperity of our cotton mills. The goods exported are mostly made by strong and prosperous corporations, paying regular dividends. They consist mainly of coarse sheetings and drills, and are sold by the manufacturers to merchants, who send them to China, Africa, and South America, in payment for tea, silk, ivory, sugar, gums, hides, and wool. They are not made by operatives who earn less than the recent or present rates of wages in England; but, in most departments of the mills, by those who earn as much or more. This competition had been fairly begun before the late war in this country, but it is now continued under better conditions. The mills of New England are now relatively much nearer the cotton fields than they were then, owing to through connections

by rail. Prior to 1860 substantially all the cotton went to the seaports of the cotton States, and from there the cost of moving it to the North or to Liverpool varied but little; but at the present day a large and annually increasing portion of the cotton used in the North is bought in the interior markets, and carried in covered cars directly to the mills, where the bales are delivered clean, and much more free from damage and waste than those which are carried down the Southern rivers on boats and barges, dumped upon the wharves, and then compressed to the utmost for shipment by sea.

In proof that this advantage is an actual one, the following example may be cited: A contract has just been made in this city for the transport of a large quantity of cotton from Texas to Liverpool, at the rate of \$1.10 per hundred pounds,—the proportion assigned to the land carriage being seventy cents; to transshipment in Boston and to the steamship, forty cents; the rate of marine insurance is three-eighths per cent; and the cost of handling in Liverpool, and transportation to Manchester, not less than a quarter of a cent per pound. Bargains may be made to bring cotton from the same point in Texas to the principal factory cities of New England, at the rate assigned to the land carriage, namely, seventy cents per hundred pounds. This cotton is brought from the interior towns of Texas to Boston, and cannot be carried to Liverpool by way of Galveston or New Orleans so cheaply, else it would not come this way. Assuming the bale to weigh five hundred pounds, at ten cents a pound, we have the following comparative cost:—

LOWELL.

Cost of cotton in Texas, 500 pounds at 10 cents, including all local charges	\$50 00
Freight to Lowell in a covered locked car, in which the cotton is protected from rain, mud, and other causes of waste, at 70 cents per 100	3 50
Total	\$53 50 10 70

LANCASHIRE.

500 pounds at 10 cents, including all local charges	\$50 00
Freight from Texas to Liverpool, at \$1.10 per 100 pounds	5 50
Insurance at three-eighths per cent on \$56	21
Transshipment in Liverpool, and freight to Lancashire, one-fourth cent	1 25
Total	\$56 96 11 39
Advantage of Lowell over Lancashire	69

There may be changes in the rates, but it does not seem probable that the relation of the land to the ocean can be much changed; and it would therefore appear that the New England manufacturer will have a permanent advantage in the price of American cotton of any given grade, varying from six to eight per cent, as the price of cotton may vary from twelve to nine cents per pound; and this advantage may be equal to twenty-five to fifteen per cent in ability to pay wages, as the cost of labor varies from a quarter to a third in the total cost of coarse and medium goods, such as constitute the chief part of the demand of the world.

It may be said that this proves too much, and that the cotton spinners of the Southern States will have the same relative advantage over New England. Let this be freely admitted: we are treating the question of the future supremacy of the UNITED STATES in the manufacture as well as the growth of cotton; and if the future changes in population, wealth, and condition of the different sections of this country, shall in the future cause the increase of spindles, especially in coarse fabrics, to be planted in the healthy hill country of Northern Georgia, Eastern Tennessee, and the Carolinas, it will simply be the greater evidence that natural laws are paramount. If Georgia has twice the advantage over Lancashire that New England now possesses, it will only be the fault of the people of Georgia if they do not reap the benefit of it.

It has been stated that our present rates of wages in our cotton factories are higher than they were in 1860, and, with our increasing prosperity, they will tend to advance; but at the same time the cost of the labor in the finished fabric *has been reduced by the greater productive power of the machinery*. The fabrics upon which by far the largest part of the spindles and looms of the country are operated may be divided substantially into the following classes:—

1st, The printing-cloth, twenty-eight-inches wide and seven yards to the pound. The cost of mill labor in making this fabric, including the salaries, wages, or earnings of every one employed, is now less than one cent, or a halfpenny, a yard.

2d, The heavy sheeting, thirty-six inches wide, and the heavy drill, thirty inches wide, both weighing two and three-fourths to three yards to one pound. The cost of mill labor in making these fabrics is about one and one-fourth cents per yard.

3d, Shirtings and sheetings, thirty to thirty-six inches wide, Nos. 20 to 30 yarns, weighing three to four yards to a pound. The cost of mill labor in these goods is from one and a half to two cents per yard.

4th, The fine sheeting or shirting, thirty to forty inches wide, No. 30 to 40 yarn, weighing three to four yards to the pound. The cost of mill labor in these goods is from one and a half to three cents per yard.

5th, Fabrics of a similar kind to the above, from one to three yards wide.

6th, Heavy cotton duck, cotton grain-bags, cotton hose, and other special articles.

7th, Blue denims, stripes, tickings, brown denims and duck, and other heavy colored goods, substantial gingham, cotton-ades, and other fancy woven fabrics of medium or heavy weight.

These seven classes comprise more than ninety-five per cent of our cotton fabrics in weight; to them are to be added lawns, woven fabric of light weight for dresses, and spool-cotton.

In respect of one-half of these fabrics, being those of the heavier grade, our proximity to the cotton field, computed at not less than half a cent per pound, oftener three-quarters, will enable the New England manufacturer to pay from twenty to thirty per cent higher wages, and yet to make the goods, other things being equal, at the same cost as his competitor in Lancashire. On a large portion of the other kinds, this advantage in the cost of cotton would be ten to twenty per cent.

The natural advantages cannot work immediate results: the ways and means of a great commerce cannot be improvised in a year, hardly in a generation. Much depends on the wisdom of our legislators in framing the acts under which our taxes are collected, whether customs or excise, and yet more upon our adherence to a specie basis in our currency; but in the long-run the only reason why we shall not assume a constantly increasing share in the cotton manufacture of the world will be the free choice that our country offers for other occupation of a more profitable or more desirable kind.

Reference has been made to the small proportion of fine spinning in the United States. Within the last few years great progress has been made in spinning and weaving fabrics of Nos. 60 to 100, such as lawns and fine dress-goods, and also in spinning fine yarn for spool-cotton. In the latter direction, yarns

as fine as No. 120 are now spun on the ring spinning-frame, a machine invented in this country, and more used than any other for warp spinning, and now being adopted in Europe. Yarns as fine as 550 are spun on mules for three-cord sewing-cotton, and for experiment much finer counts have been reached. It has often been alleged that fine yarns could not be as well spun in the United States as in England, owing to the dry and electrical conditions of the atmosphere during a considerable part of the year. This difficulty has existed in some degree, although not so as to preclude fine work if it had been profitable to undertake it; but, as far as this difficulty existed, it has lately been entirely removed by the invention of a very simple and inexpensive apparatus for moistening the air with the finest spray of pure cold water, by which method the air of a spinning or weaving room may be kept at any desired degree of humidity in the driest day, so that the adverse effect of electricity is entirely overcome.

Whenever the condition and extension of our market will warrant the undertaking, there is now no obstacle to our manufacturing any variety of cotton fabric that is in demand, either coarse or fine.

The following examples will give an adequate idea of the construction and general appearance of American cotton factories, and of the dwelling-places of the operatives:—

[The completed work will be illustrated with steel engravings of several of our best mills.]

The following examples will give an adequate idea of the mode of construction of American cotton machinery and other apparatus connected with cotton mills, nearly all the diagrams being of machines that are in some respects peculiar to this country. [In the completed work diagrams and descriptions will be given of such machines as the following.]

The Kitson opener; Whitehead & Atherton lapper; Foss & Peavey card; Whitin Machine-shop card (self-stripper); Saco Water Power Company roving-frame; Sawyer ring spinning-frame; Whitin ring spinning-frame; Fales & Jenks Manufacturing Company Rabbeth spinning-frame; Mason mule; Lowell slasher; Lewiston warper; Lyall loom (wide); Empire loom (fast); Knowles loom (fancy); Blake pump; Parmelee automatic sprinkler; Fales & Jenks Manufacturing Company rotary pump; Holyoke Machine-shop water-wheels; Garland moistener.

It is suggested that the complete work, of which this publication is a specimen, may be made more complete in the department of cotton and cotton manufacturing, if persons interested will communicate additional information or suggestion to the undersigned.

E. A.

Boston, October, 1879.

[From "The American Architect" of Sept. 20, 1879.]

THE VIBRATION OF MILL BUILDINGS.

Boston, September, 1879.

TO THE EDITOR OF THE AMERICAN ARCHITECT.

Dear Sir, — Assuming that a large factory or machine-shop is to be constructed upon the slow-burning principle, with open timbers, plank floors, deck roof, &c., there remain other points to be considered, which do not appear to have yet received sufficient attention from either the mill-engineer, the professional architect, or the builder.

In many of the existing mills, even of apparently the best construction, there is a great tendency to vibration; and in some of the mills that are high and narrow, the vibration is very great. When it is considered that the lateral motion which constitutes this vibration has been imparted to the whole structure, and that it causes a pressure of every bearing in the mill, first on one side and then on the other, it will be obvious that a great deal of power must be wasted, not only to induce this motion, but also to overcome the additional friction caused by it, especially in heavy bearings.

If the common method of constructing a factory be considered, its faults may be apparent, and possibly the remedy. Assume an ordinary mill, 350 to 500 feet by 72 feet, four or five stories high, with towers to brace the centre only; throughout the greater part of the length the section showing two rows of posts and two side walls, with no brace whatever to prevent them from yielding or bending in some degree either way. There are mills within our knowledge in which a pail of water two-thirds full cannot be set upon the upper floor without slopping over; others in which gas-pendants will sway from side to side more than two inches. One mill was lately inspected, of unusually good construction, built of stone, with arched brick floors, four stories high, carrying very heavy machinery for working flax. On the first floor of the mill it was observed that the gas-pendants hung from the second floor had a very marked swing from side to side. We have the record of another large mill construction with iron beams, in which, before the machinery could be operated with

any success, it became necessary to put wooden beams under the iron, and to lift the iron from the brick walls so that all the bearings should come upon the wood.

This vibration has been attributed chiefly to the motion of the looms; and it is now customary to place looms across the mill, and not lengthwise, and also upon a lower floor, as far as possible. In some cases one-half the looms are operated at a little lower speed than the other half, in order to avoid a synchronous movement of the lathes; but there are many other causes of vibration, even in the rotary motions of other machines and of the shafting, pulleys, and belts. Wherever there is friction there is a cause of vibration; and when it is necessary to construct a mill or workshop above one story in height, a remedy must be sought in the method of construction.

Mill construction appears to have been considered more with reference to the support of dead weight than to stiffness or absence of vibration. In point of fact, the dead weight to be sustained in a cotton or woollen mill is very little. If we take as an example a mill of 32,000 cotton spindles on No. 24 yarn, the floor space and dead weight of the machinery, omitting openers and pickers, which would, almost as a matter of course, be placed upon a concrete floor in a separate building, would be substantially as follows:—

COMPUTATION FOR A COTTON MILL OF 32,000 SPINDLES.

No. 24 Yarn.

	Pounds, about.	Total.	Stock.	Shafting.	Operatives.	Total Weight.	Floor Space.	Average Weight.
6 Lappers.....	12,000	72,000	280	13,000	300	85,580	In sep. build'g.	
240 36-inch Cards.....	1,600	384,000	4,800	11,920	275	400,995	} 17,856	23.30
2 Doublers.....	980	1,960	40	1,100		3,100		
12 R. W. Heads.....	800	9,600		1,100	180	10,680		
21 Drawing.....	2,000	42,000	850	1,250	180	44,280	5,184	8.52
36 Roving Frames.....	9,000	324,000	2,000	14,500	4,300	344,800	12,528	27.52
90 Spinning Frames, 176 Spindles each....	4,000	360,000	15,340	125,000	1,820	502,160	15,984	31.42
24 Mules, 672 Sps. each	10,000	240,000	16,000	24,000	2,800	282,800	24,192	11.60
8 Spoolers.....	2,600	20,800	890	5,000	825	27,515	} 5,184	6.15
6 Warpers.....	450	2,700	760	410	500	4,370		
2 Slashers.....		4,000	5,600	2,200	480	12,280		
8 Drawing-in Frames.	60	480	1,600		1,000	3,080	5,760	26.66
800 Looms.....	800	640,000	128,000	140,000	16,000	924,000	36,864	25.07
		2,029,540	175,880	326,480	28,360	2,560,260	123,552	20.72
		Add for contingencies 20 per cent.....				512,052		
						3,072,302		24.86

The greatest concentration of weight is immediately under the

slashers; and, as the floor reserved around the slashers is used to pile loaded yarn-beams upon, the weight at this point is relatively much more than the figures show.

A mill floor constructed in the usual manner would consist of beams 12 by 14 inches in one or two parts, 8 feet on centres, 3-inch plank, $1\frac{1}{4}$ -inch top floor. The material would usually be hard pine and spruce; this would be substantially equivalent to 6 inches of wood of uniform thickness. Spruce weighs 30 pounds per cubic foot; Georgia pine, 48 pounds. On these figures the floor described would be equal to $19\frac{1}{2}$ pounds weight to each superficial foot of floor surface. If $\frac{3}{4}$ -inch mortar were used between the floors, it would add about 6 pounds per square foot, — making $25\frac{1}{2}$ pounds in all. The total weight of floor and load is, therefore, from 50 to 60 pounds per foot of surface in the principal departments of the mill. If the load be multiplied by 8, the standard of the beams would be to bear a breaking strain of 250 pounds per foot of surface, or 50,000 pounds on each beam 25 feet long, supporting 4 feet of floor on each side of the centre, — 200 square feet per beam. (An actual weight equal to this was lately found in a warehouse used for storing cheese.) The weight of the floor itself would be distributed about in the proportion of 7 pounds in the beams, and $12\frac{1}{2}$ pounds in the plank and boards of the floor. These figures would be varied a little, according to the kind of timber and plank used. In a mill 72 feet wide in the clear, with two rows of posts, the beams must each be a little more than 24 feet long; and it is obvious that there must be a very great proportionate weight on the centre of each beam, and therefore a tendency to sag in the middle. What that means in respect to the adjustment of shafting, and the operation of machinery, every manufacturer knows to his cost and trouble.

How to stiffen the beams without exposing iron truss-rods, such as are commonly used, to the action of fire, — as the combustion of the contents only of almost any room of a textile factory would heat truss-rods so as to make them useless, and would probably heat and destroy iron beams, — would seem to be a suitable question.

The problem is, how to get the strength of iron and the slow burning of a heavy wooden beam. Objections are made by some engineers to composite beams of iron and wood; and it is not desirable to reduce the substance of the wood more than one-half, — that is, not to have either of the two parts of a beam much thinner or more combustible than the floor.

It is alleged that the weight upon a floor sustained by a composite or "flitch" beam will rest either on the iron or on the wood, and cannot be brought upon both together. If your correspondents have any data upon this point, it would be interesting to the mill constructors to know them.

It has been suggested that a factory may be braced with inside rods ; but it is desirable to avoid rods, because of their tendency to collect lint.

The equivalent of the knees used in the construction of a ship has been suggested ; but it is desirable *not* to tie the beams to the walls, so as to prevent the ends rolling out of their bearings in case they break or burn one at a time.

Buttresses would doubtless serve a good purpose, but they are somewhat objectionable if deep enough to obstruct light in the lower stories.

Our problem therefore is, how to construct the walls, either solid or hollow ; how to brace the posts ; and how to construct the beams so as to give the utmost stiffness, and so as to avoid vibration.

There are problems not yet solved in respect to the construction of the frames of machinery as well as of the mills, that would perhaps repay scientific study with a view to avoiding vibration, — a familiar example of the unscientific use of material being the original use of stone sleepers on the Lowell Railroad.

The problem of rightly combining wood and metal in the framework of rapidly moving machinery, and wood, metal, brick, or stone in the construction of the factory, appears to offer a wide field for saving in power, friction, wear, and waste.

These points are stated as indicating some of the points that might be well considered by the student of *industrial architecture*, and every attempt at architectural effect must be absolutely subordinate to them. The only true effect that can be rightly aimed at must be that which gives expression to these considerations of safety and utility.

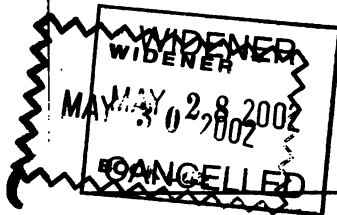
E. A.



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